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Effect of carrot powder incorporation on the quality of pasta

Abstract

Carrot powder at 5, 10, 15, 20, 25 and 30% was incorporated into wheat flour to produce pasta. The quality of the resulting wheat-carrot pasta was evaluated. There was significant ($p<0.05$) decrease in moisture (8.95 to 8.76%), crude protein (12.82 to 10.84%) and carbohydrate (75.59 to 74.13%) contents of the wheat-based pasta. Conversely, crude fat (1.38 to 1.49%), crude fiber (0.82 to 2.43%) and ash (0.44 to 2.35%) contents increased. Increment in vitamins B_1 (0.41 to 0.44mg/100g), B_3 (3.35 to 3.80mg/100g), B_6 (0.38 to 0.54mg/100g), C (0.54 to 3.14mg/100g), E (0.68 to 1.54mg/100g), K (1.81 to 29.28 µg/100g) and beta carotene (1.03 to 6.13mg/100g) content was observed with carrot incorporation in a concentration dependent manner. Calcium, iron, potassium and sodium contents increased significantly ($p<0.05$) from 33.47 to 84.03mg/100g, 3.55 to 3.70mg/100g, 359.30 to 960.70mg/100g and 2.00 to 64.37mg/100g respectively. Apparent and bulk densities of the pasta significantly ($p<0.05$) increased (0.76 to 0.86gml^{-1} and 1.56 to 1.69gml^{-1} respectively) with increase in carrot powder. Pasta with 10% carrot powder was most generally most accepted. The study has shown that acceptable and micronutrient enriched pasta can be produced from wheat flour incorporated with carrot powder up to 30%.

Keywords: pasta, wheat flour, carrot powder, quality, beta carotene

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Introduction

Pasta is the term given to a group of extruded foods such as noodles, macaroni and spaghetti. These foods continue to gain popularity in the diets of individuals especially among children under five years.[1] They are industrially produced using extrusion technology; a process which combines several unit operations including mixing, kneading, shearing, shaping, and forming.[2] In small scale and home preparations, pasta is produced using either manual or automatic pasta makers.

Pasta products are obtained mainly by mixing milled wheat and water.[3] They are ubiquitous around the world and are believed to have originated from Italy as far back as 1279.[4]

Wheat remains the major cereal used in the production of pasta owing to its considerably high amounts of gluten proteins which are responsible for dough formation when the flour is mixed with water.[5] Although cereals such as wheat and their products are excellent sources of energy and B-vitamins, they are low in other micronutrients such as beta carotene (precursor of vitamin A). Consequently, extensive consumption of cereal based foods might predispose individuals to micronutrient malnutrition. Young children are the most vulnerable and if not adequately addressed, malnutrition can lead to a permanent negative impact on their quality of life.[6]

Carrot (*Daucus carota L*) is one of the popular sources of vitamins and dietary carotenoids in many countries.[7,8] According to Speizer et al.[9] carrot has gained increased attention over the years due to its richness in antioxidants and beta carotene (pro-vitamin A) activity.

The need to enhance the pro-vitamin A content of pasta using readily available food such as carrots has been elucidated.[1] This will help reduce the incidence of vitamin A deficiencies associated with prolonged consumption of pasta products. The objective of this study was therefore to evaluate the effect of carrot powder incorporation on the quality of pasta.

Materials and methods

Sample procurement

Wheat (*Triticum durum*) flour and carrot (*Daucus carota*) roots were purchased from Modern market, Makurdi, Benue State, Nigeria.

Sample preparation

Wheat flour was partially substituted with carrot powder up to 30% to produce pasta using a pasta maker (Imperia Tipo Lusso SP150, Torino, Italy) according to the method described by Walsh and Gilles.[10] Wheat-carrot composite flour (100g) was mixed with about 30–35% warm water (50°C) and kneaded. The dough was allowed to rest for 15min, followed by cutting using a pasta maker. Pasta strands were then steamed by spreading on a wire gauze and placed over a water bath boiling at 100°C for 10min before drying in a hot air oven (GENLAB, England B6S, serial no: 85K054) at 60°C for 2h. The dried pasta samples were cooled and packaged in sealed high density polyethylene bags prior to analysis (Figure 1).

Figure 1 Pasta incorporated with carrot powder.

Abbreviations: WF, wheat flour; CP, carrot powder.

Methods of analyses

Determination of proximate composition: Moisture content, crude protein, crude fat, crude fiber and ash contents of wheat-carrot pasta samples were determined using standard methods.[11] Carbohydrate content was calculated by difference.[12]

Determination of vitamins and beta-carotene: Vitamins B_1, B_3, B_6, E and K were determined using HPLC (Model: BLC-10/11, BUCK SCIENTIFIC, USA) techniques as described by AOAC.[11] Vitamin C was determined according to the method described by Mohammed et al.[13] Beta carotene was determined using a spectrophotometer (model 22UV/VIS) according to the method of AOAC.[11]

Determination of minerals: Mineral content of pasta was determined after drying and ashing. The ash was dissolved in 100 ml of 10% hydrochloric acid, filtered and estimated quantitatively using an atomic absorption spectrophotometer (scientific model VGP 210) using filters matching the selected minerals as described by AOAC.[11]

Determination of physical properties: Length and diameter were measured by means of a vernier caliper **(**Mitutoyo, Tokyo, Japan**)**. Apparent density,[14] porosity,[15] bulk density[16] and expansion ratio[16] were also determined.

Sensory evaluation: The cooked pasta samples were served to a semi trained 20-member panel to evaluate such attributes as appearance, aroma, taste, mouth feel, stickiness and overall acceptability using a 9-point hedonic scale.

Statistical analysis: Experiments were conducted in triplicates. Data obtained were statistically analyzed using analysis of variance (ANOVA). Means were separated by Fisher's Least Significance Difference Test and significant difference was accepted at 5% level of probability ($p<0.05$) using the genStat (17th edition).

Results

Effect of carrot powder incorporation on the proximate composition of pasta

Proximate composition of carrot incorporated pasta is shown in Table 1. Decrease in moisture (8.95 to 8.76), protein (12.82 to 10.84%) and carbohydrate (75.59 to 74.13%) were observed with increasing amounts of carrot in pasta. Conversely, fat, fiber and ash contents significantly ($p<0.05$) increased in a concentration dependent manner with carrot powder incorporation from 1.38 to 1.49%, 0.82 to 2.43% and 0.44 to 2.35% respectively.

Effect of carrot powder incorporation on selected vitamins and β-carotene of pasta

Incorporation of carrot powder into pasta resulted in significant ($p<0.05$) increase in Vitamins B_1 (0.41 to 0.44mg/100g), B_3 (3.35 to 3.80mg/100g), B_6 (0.38 to 0.54mg/100g), C (0.54 to 3.14mg/100g), E (0.68 to 1.54mg/100g) and K (1.81 to 29.28µg/100g, respectively). Beta carotene was not detected in pasta from 100% wheat flour. Highest value of 6.13mg/100g was obtained for 30% carrot enriched pasta (Table 2).

Table 1 Effect of carrot powder incorporation on the proximate composition (%) of pasta

WF:CP	Moisture	Crude Protein	Crude Fat	Crude Fibre	Ash	CHO
100:0	$8.95^{a}\pm0.02$	$12.82^{a}\pm0.01$	$1.38^{a}\pm0.01$	$0.82^{a}\pm0.01$	$0.44^{a}\pm0.01$	$75.59^{a}\pm0.06$
95:5	$8.92^{a}\pm0.02$	$12.50^{b}\pm0.03$	$1.39^{ab}\pm0.03$	$1.13^{b}\pm0.03$	$0.74^{b}\pm0.02$	$75.32^{b}\pm0.10$
90:10	$8.90^{ab}\pm0.04$	$12.16^{c}\pm 0.04$	$1.42^{bc}\pm0.02$	$1.44^{c}\pm0.02$	$1.07^{c}\pm0.02$	$75.01^{c}\pm0.13$
85:15	$8.85^{bc}\pm0.03$	$11.85^{d}\pm0.04$	$1.44^{cd}\pm0.01$	$1.77^{d}\pm0.03$	$1.38^{d}\pm0.02$	$74.71^{d}\pm0.12$
80:20	$8.84^{cd}\pm0.04$	$11.53^{e}\pm0.04$	$1.45^{cd}\pm0.03$	$2.10^{e}\pm0.03$	$1.72^{e}\pm0.01$	$74.36^{e}\pm0.14$
75:25	$8.79^{de}\pm0.01$	$11.18^{f}\pm0.03$	$1.47^{de}\pm0.02$	$2.41^{f}\pm0.02$	$2.04^{f}\pm0.02$	$74.11^{f}\pm0.09$
70:30	$8.76^{e}\pm0.03$	$10.84^{g}\pm0.02$	$1.49^{e}\pm0.02$	$2.43^{f}\pm0.02$	$2.35^{g}\pm0.03$	$74.13^{f}\pm0.11$
LSD	0.05	0.06	0.03	0.04	0.03	0.19

*Values are means±standard deviations of triplicate determinations. Means with same superscript in same column are not significantly ($p>0.05$) different.
Abbreviations: WF, wheat flour; CP, carrot powder; CHO, carbohydrate; LSD, least significant difference.

Table 2 Effect of carrot powder incorporation on selected vitamins and β-carotene of pasta

WF: CP	B_1 (mg/100g)	B_3 (mg/100g)	B_6 (mg/100g)	C (mg/100g)	E (mg/100g)	K (µg/100g)	β-carotene (mg/100g)
100:0	$0.41^{a}\pm0.01$	$3.35^{a}\pm0.03$	$0.38^{a}\pm0.03$	ND	$0.68^{a}\pm0.02$	$1.81^{a}\pm0.02$	ND
95:5	$0.42^{ab}\pm0.01$	$3.44^{b}\pm0.04$	$0.41^{ab}\pm0.02$	$0.54^{a}\pm0.03$	$0.80^{b}\pm0.01$	$6.60^{b}\pm0.61$	$1.03^{a}\pm0.03$
90:10	$0.42^{ab}\pm 0.01$	$3.51^{c}\pm0.02$	$0.43^{bc}\pm0.01$	$1.03^{b}\pm0.03$	$0.99^{c}\pm0.02$	$11.09^{c}\pm0.08$	$2.03^{b}\pm0.02$
85:15	$0.43^{bc}\pm0.01$	$3.60^{d}\pm0.01$	$0.45^{cd}\pm0.02$	$1.56^{c}\pm0.02$	$1.13^{d}\pm0.03$	$15.31^{d}\pm0.02$	$3.06^{c}\pm0.04$
80:20	$0.43^{bc}\pm0.00$	$3.65^{e}\pm0.03$	$0.48^{de}\pm0.01$	$2.11^{d}\pm0.03$	$1.28^{e}\pm0.02$	$19.46^{e}\pm0.01$	$4.08^{d}\pm0.02$
75:25	$0.43^{bc}\pm0.01$	$3.73^{f}\pm0.02$	$0.50^{e}\pm0.03$	$2.68^{e}\pm0.03$	$1.46^{f}\pm0.04$	$24.61^{f}\pm0.02$	$5.07^{e}\pm0.03$
70:30	$0.44^{c}\pm0.01$	$3.80^{g}\pm0.02$	$0.54^{f}\pm0.01$	$3.14^{f}\pm0.03$	$1.54^{g}\pm0.04$	$29.28^{g}\pm0.42$	$6.13^{f}\pm0.02$
LSD	0.01	0.04	0.03	0.05	0.05	0.49	0.04
DRIs (IOM)	0.6*	8*	0.6*	25*	7*	55**	4.8*
AV*	83.94%	89.70%	89.81%	85.21%	88.68%	93.13%	89.64%

*Values are means±standard deviations of triplicate determination. Means with same superscript in same column are not significantly ($p>0.05$) different.
Abbreviations: WF, wheat flour; CP, carrot powder; ND, not detected; LSD, least significant difference; DRIs, dietary reference intakes; (*Recommended dietary allowance, **Adequate intake), IOM, institute of medicine (1998); AV*, average retention after processing.

Effect of carrot powder incorporation on minerals content of wheat-carrot pasta

Significant ($p<0.05$) increment in calcium (33.47 to 84.03mg/100g), iron (3.55 to 3.70mg/100g, potassium (359.30 to 960.70mg/100g) and sodium (2.00 to 64.37mg/100g) contents were observed with increase in carrot powder into pasta (Table 3). There was however no significant ($p>0.05$) difference in copper content between pasta from 100% wheat flour and those incorporated up to 25% carrot powder. Zinc, magnesium and manganese contents decreased with increasing levels of carrot from 2.60 to 2.31mg/100g, 4.07 to 3.21mg/100g and 134.90 to 130.80mg/100g respectively.

Effect of carrot powder incorporation on the physical properties of pasta

Table 4 shows the effect of carrot powder incorporation on the physical properties of pasta. Samples were significantly ($p<0.05$) different in length (46.04 to 90.13mm) and weight (0.22 to 0.43g). Reduction in diameter (1.95 to 1.87mm), porosity (1.06 to 0.97) and expansion ratio (1.03 to 0.97) of pasta was observed with increase in carrot powder. Conversely, apparent and bulk densities significantly ($p<0.05$) increased (0.76 to 0.86gml^{-1} and 1.56 to 1.69gml^{-1} respectively).

Table 3 Effect of carrot powder incorporation on selected minerals (mg/100g) of pasta

WF: CP	Calcium	Iron	Copper	Zinc	Manganese	Magnesium	Potassium	Sodium
100:0	33.47^{a}±0.55	3.55^{a}±0.08	0.41^{a}±0.01	2.60^{a}±0.02	4.07^{a}±0.02	134.90^{a}±3.51	359.30^{a}±8.14	2.00^{a}±0.02
95:5	42.50^{b}±1.44	3.61^{b}±0.01	0.41^{a}±0.00	2.54^{b}±0.04	3.93^{b}±0.02	134.70^{a}±3.23	444.40^{b}±23.71	13.22^{b}±1.07
90:10	51.37^{c}±1.51	3.62^{bc}±0.01	0.41^{a}±0.00	2.50^{b}±0.02	3.75^{c}±0.03	134.40^{ab}±1.23	550.90^{c}±20.36	23.77^{c}±1.66
85:15	60.57^{d}±1.70	3.64^{bc}±0.01	0.41^{a}±0.00	2.45^{b}±0.02	3.62^{d}±0.01	133.80^{ab}±0.69	649.00^{d}±42.52	32.87^{d}±1.85
80:20	68.98^{e}±1.66	3.66^{bcd}±0.01	0.41^{a}±0.01	2.37^{c}±0.04	3.56^{e} ±0.05	132.70^{ab}±1.55	744.10^{e}±39.53	46.67^{e}±0.21
75:25	76.58^{f}±2.01	3.67^{cd}±0.01	0.40^{ab}±0.01	2.33^{cd}±0.03	3.34^{f}±0.02	131.80^{ab}±1.57	824.90^{f}±22.80	53.20^{f}±2.58
70:30	84.03^{g}±3.51	3.70^{d}±0.02	0.39^{b}±0.01	2.31^{d}±0.04	3.21^{g} ±0.01	130.80^{b}±1.57	960.70^{g}±49.13	64.37^{g}±3.97
LSD	3.42	0.05	0.01	0.05	0.04	3.75	56.74	3.61
DRIs (IOM)	800*	10*	0.44*	5*	1.5**	130*	3800**	1200**

*Values are means±standard deviations of triplicate determinations. Means with same superscript in same column are not significantly ($p>0.05$) different.
Abbreviations: WF, wheat flour; CP, carrot powder; LSD, least significant difference; DRI, dietary reference intakes; (*recommended dietary allowance, **Adequate intake), IOM, institute of medicine (1997).

Table 4 Effect of carrot powder incorporation on the physical properties of pasta

WF: CP	Length (mm)	Weight (g)	Diameter (mm)	Apparent Density (gml^{-1})	Bulk Density (gml^{-1})	Porosity	Expansion Ratio
100:0	90.13^{a}±0.02	0.43^{a}±0.01	1.95^{a}±0.01	0.76^{a}±0.01	1.56^{a}±0.02	1.06^{a}±0.01	1.03^{a}±0.01
95:5	46.97^{b}±0.02	0.22^{b}±0.01	1.94^{ab}±0.01	0.78^{ab}±0.01	1.57^{a}± 0.01	1.04^{ab}±0.01	1.02^{ab}±0.01
90:10	54.20^{c}±0.01	0.25^{c}±0.01	1.93^{bc}±0.01	0.78^{ab}±0.01	1.57^{a}± 0.01	1.03^{bc}±0.01	1.01^{ab}±0.01
85:15	58.53^{d}±0.02	0.27^{cd}±0.02	1.92^{c}±0.01	0.80^{bc}±0.01	1.62^{b}± 0.01	1.01^{c}±0.02	1.00^{bc}±0.01
80:20	60.07^{e}±0.03	0.29^{d}±0.01	1.90^{d}±0.01	0.82^{cd}±0.01	1.64^{bc}±0.02	1.00^{cd}±0.01	1.00^{bc}±0.01
75:25	52.39^{f}±1.56^{g}	0.24^{bc}±0.01	1.89^{d}±0.01	0.84^{de}±0.01	1.66^{c}± 0.02	0.98^{de}±0.01	0.98^{cd}±0.01
70:30	46.04±0.97	0.22^{b}±0.01	1.87^{e}±0.01	0.86^{e}±0.02	1.69^{d}± 0.01	0.97^{e} ±0.02	0.97^{d}±0.01
LSD	1.22	0.02	0.01	0.02	0.02	0.02	0.02

*Values are means±standard deviations of triplicate determinations. Means with same superscript in same column are not significantly ($p>0.05$) different.
Abbreviations: WF, wheat flour; CP, carrot powder; LSD, least significant difference.

Effect of carrot powder incorporation on the sensory attributes of pasta

Acceptance of pasta decreased in terms of appearance, mouth feel, and overall acceptability. Aroma of pasta was improved by carrot powder incorporation. The taste of pasta was enhanced by carrot powder until after 15% incorporation, where decline set in. Carrot incorporation led to significant ($p<0.05$) decline in mouth feel (7.60 to 5.80). Reduction in stickiness of pasta was directly proportional to increasing carrot powder into pasta. Mean scores for pasta overall acceptability ranged from 5.85 to 7.60. Overall acceptability was highest in pasta containing 10% carrot powder.

Discussion

The significant reduction in crude protein with carrot powder incorporation could be attributed to dilution effect from carrot powder, which is particularly lower in protein than wheat flour (Table 1). The results are in conformity with those reported by other researchers for wheat composite flours.[17,18] The low moisture content of the pasta samples is an indication of good keeping quality.[19] The increment in fiber content of pasta in the present study suggests its potential in reducing risks of colon cancer and other related health conditions. Similar increment in fiber has been reported by Kumar et al.[20] for carrot powder incorporated into chicken cutlets. The increasing ash contents are an indication of the rich mineral contribution due to carrot. The reduction in carbohydrate content with carrot incorporation is consistent with the findings of Omachi & Yusufu [21] for carrot enriched millet-based biscuit.

Carrot is considered a rich source of vitamins and beta carotene. Its incorporation into pasta resulted in increments in vitamin content (Table 2). The benefits of vitamins are well documented in literature.[22,23] At 25% carrot incorporation, the recommended dietary allowance of 4.8mg/100g for infants below 8years was met.[24] In addition to the antioxidant role of beta carotene, it is also a pro-vitamin A. Beta carotene has also been reported to confer possible protective effect against some types of cancers.[25,26] The cold processing technology combined with short time steaming did not adversely affect the retention of vitamins in pasta. Average retention

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of vitamins B_1 (83.94%), B_3 (89.70%), B_6 (89.81%), C (85.21%), E (88.68%), K (93.13%) and beta carotene (89.64%) were in conformity with those reported by other researchers.[22,27]

The increase in calcium content of the pasta is directly related to its higher proportion in carrot (Table 3). Zabidi et al.[28] reported higher values for noodles substituted with different levels of mangosteen pericarp powder. The increment in iron content, may support energy production, growth and development, immune functions, red blood cell formation, reproduction and wound healing.[29] Copper and manganese contents of pasta in this study were lower than those reported in wheat noodles supplemented with cauliflower leaf powder.[30] Zinc and magnesium contents were in conformity with values reported for noodles substituted with mangosteen pericarp powder.[28] Manganese and magnesium contents in this study were higher than the dietary reference intakes (1.5mg/100g and 130mg/100g respectively) for children under 8years.[31] Carrots are reasonably higher sources of sodium and potassium than wheat, hence the increment of these minerals in pasta. Similar increase in potassium and sodium contents of pasta incorporated with selected vegetables has been reported.[32]

Increasing weight per length of pasta was observed in a concentration dependent manner with carrot powder incorporation (Table 4). Increase in weight with compositing has been reported by Baljeet et al.[33]Gluten proteins are the structure forming proteins in wheat. The reduction in gluten proteins with increase in carrot may have accounted for the reduction in diameter of the pasta. Okafor & Ugwu[34] reported similar decrease in diameter for extruded product from blends of breadfruit, cashew nut and coconut. Apparent and bulk densities were higher than those reported by Okafor & Ugwu.[34] A direct relational trend was observed for porosity and expansion ratio of pasta. The decreasing porosity and expansion ratio as more carrot was incorporated could be due to decrease in structure forming proteins, which suppressed the rising capacity of the dough. Increase in fiber and bulk density has also been reported to reduce product expansion.[35] As bulk density increased, air spaces became closed up leading to the trapping of gas bubbles necessary for expansion, thus limiting the expansion of the pasta.

The decline in appearance of pasta in the present study (Table 5) may be attributed to the aversion of panelist towards the increasing yellowish colour of the product as more carrot powder was added, similar to the report of Turksoy & Ozkaya[36] Carrots are reported to improve aroma and taste of foods owing to their concentration of aromatic essential oils.[37] The increase in insoluble fiber occasioned by carrot powder incorporation may have resulted in a rough texture of the end product, thus affecting mouth feel of pasta. According to Foschia et al.[38], the main challenge of incorporating rich-fiber ingredients in cereal products is the adverse effect on the end product quality, mainly due to changes in texture and colour properties. The reduction in stickiness with carrot powder incorporation was preferred by the panelists. This reduction could be due to starch replacement in the blend. Piwinska et al.[39] reported similar reduction in stickiness of wheat-oat pasta. Pasta with 10% carrot was most accepted by the panelists. Generally, incorporation of less than 30% vegetable powders into pasta does not adversely affect the overall acceptability of the product.[32]

Table 5 Effect of carrot powder incorporation on the sensory attributes of pasta

WF: CP	Appearance	Aroma	Taste	Mouthfeel	Stickiness	Overall Acceptability
100:0	7.90^{a}±0.59	7.00^{a}±0.69	6.95^{abc} ± 0.69	7.60^{a}±0.68	7.00^{a}±0.42	7.25^{a}±0.44
95:5	7.55^{b}±0.76	7.10^{ab}±0.73	7.10^{abc}±0.72	7.50^{ab}±0.61	7.00^{a}±0.68	7.45^{ab}±0.50
90:10	7.50^{b}±0.76	7.15^{ab}±0.60	7.15^{ab}±0.7	7.20^{b}±0.62	7.55^{b}±0.72	7.60^{b}±0.51
85:15	6.95^{c}±0.60	7.35^{bc}±0.75	7.25^{a}± 0.79	6.45^{c}±0.76	7.70^{b}±0.74	7.05^{ac}±0.60
80:20	6.00^{d}±0.00	7.60^{c}±0.50	6.85^{abc}±0.81	6.20^{c}±0.41	7.70^{b}±0.88	6.65^{d}±0.49
75:25	5.70^{de}±0.47	7.65^{c}±0.60	6.75^{bc}±0.75	6.10^{cd}±0.31	7.75^{b}±0.89	6.10^{e}±0.31
70:30	5.60^{e}±0.50	7.65^{c}±0.76	6.65^{c}±0.64	5.80^{d}±0.41	7.80^{b}±1.11	5.85^{e}±0.37
LSD	0.36	0.30	0.46	0.35	0.50	0.30

*Values are means±standard deviations (n=20). Means with same superscript in same column are not significantly (p>0.05) different.

Abbreviations: WF, wheat flour; CP, carrot powder; LSD, least significant difference.

Conclusion

The study revealed that incorporation of carrot into pasta enhanced its chemical composition. The dietary reference intake (4.8mg/day) for beta carotene was met at 25% carrot incorporation into pasta, signifying its potential in the management of vitamin A related conditions. The physical characteristic of pasta was affected by carrot incorporation. Pasta incorporated with 10% carrot was most accepted in terms of overall acceptability.

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Conflict of interest

The authors declare that there is no conflict of interest.

References

1. Sule S, Abu JO. Consumption of Extruded Foods among Under–Fives: Vitamin A Awareness and Fortificant Preferences of their Caregivers in Makurdi, Nigeria. *Nigerian Journal of Nutritional Sciences*. 2017;38(1):1–9.
2. Riaz MN, editors. *Extruders in food applications*. USA: Lancaster; Technomic Publishing Co Inc; 2000.
3. Li M, Zhu K, Guo X, et al. Natural Additives in Wheat–Based Pasta and Noodle Products: Opportunities for Enhanced Nutritional and Functional Properties. *Comprehensive Reviews in Food Science and Food Safety.* 2014;13(4):347–357.

4. Matsuo RR. Durum wheat: Production and processing. In: Bass E, editor. *Grains and Oilseeds: Handling, Marketing, Processing*. 4th ed. Canada: Canadian International Grains Institute;1993:779–807.

5. Macrae R, Robinson RK, Sadler MJ. *Encyclopedia of Food science, Food Technology and Nutrition*. San Diego: Academic press Inc; 1993.

6. Sandoval–Priego AA, Reyes–Morals D, Perez–Cuevas R, et al. Family life strategies and their relation with malnutrition in children under 2 years old. *Salud Publica Mex.* 2002;44(1):41–49.

7. Torronen R, Lehmusaho M, Hakkinen S, et al. Serum β–carotene response to supplementation with raw carrots, carrot juice or purified β–carotene in healthy nonsmoking women. *Nutrition Research.* 1996;16(4):565–575.

8. Haq R, Prasad K. Nutritional and processing aspects of carrot (*Daucus carota*)–A review. *South Asian J. Food Technol. Environ.* 2015:1(1):1–14.

9. Speizer FE, Colditz GA, Hunter DJ, et al. Prospective study of smoking, antioxidant intake and lung cancer in middle-aged women (USA). *Cancer Causes Control.* 1999;10(5):475–482.

10. Walsh DE, Gilles KA. Pasta Technology. In: Desrosier NW, editor. *Elements of Food Technology*. Paris: AVI Publishing Company Inc; 1977. 772 p.

11. George W Latimer. *Official Methods of Analysis of AOAC international*. 19th ed. USA: AOAC International, Gaithersburg; 2012.

12. Ihekoronye AI, Ngoddy PO. *Integrated Food Science and Technology for the Tropics*. UK: Macmillan Publ Ltd; 1985.

13. Mohammed QY, Hamad WM, Mohammed EK. Spectrophotometric Determination of Total Vitamin C in Some Fruits and Vegetables at Koya Area – Kurdistan Region/ Iraq. *Journal of Kirkuk University–Scientific Studies.* 2009:4(2):46–54.

14. Onyango C, Noetzold H, Bley T, et al. Proximate composition and digestibility of fermented and extruded *uji* from maize–finger millet blend. *Lebensmittel Wissenschaft und Technologie.* 2004;37(8):827–832.

15. Thymi S, Krokida MK, pappa A, et al. Structural properties of extruded corn starch. *Journal of Food Engineering.* 2005;68(4):519–526.

16. Ding Q, Ainsworth P, Tucker G, et al. The effect of extrusion conditions on the physicochemical properties and sensory characteristics of rice–based expanded snacks. *Journal of Food Engineering.* 2005;66(3):283–289.

17. Taneya MLJ, Biswas MMH, Shams–Ud–Din M. The studies on the preparation of instant noodles from wheat flour supplementing with sweet potato flour. *Journal of the Bangladesh Agricultural University.* 2014;12(1):135–142.

18. Hussein MA, Yonis AAM, Abd El – Mageed HA. Effect of adding Carrot Powder on the Rheological and Sensory Properties of Pan Bread. *J. Food and Dairy Sci., Mansoura Univ.* 2013;4(6):281–289.

19. Sengev IA, Nwobi I, Sule S. Effect of Crayfish Inclusion on the Chemical and Sensory Properties of Ogi Prepared from Maize, Millet and Sorghum. *International Journal of Nutrition and Food Sciences.* 2016;5(6):378–383.

20. Kumar Y, Shukla P, Singh P, et al. Effect of Dried Carrot Powder Incorporation on Quality Attributes of Chicken Cutlets. *Journal of Ready to Eat Food*s. 2015;2(3):89–95.

21. Omachi DO, Yusufu PA. Physico–chemical, sensory and microbiological assessment of millet based biscuits improved with cashew nuts (*Anarcadium occidentale*), carrot flour (*Daucus carota*). *American Journal of Food and Nutrition.* 2017;7(1):13–22.

22. James S, Nwabueze TU. Quality Evaluation of Extruded Full Fat Blend of African Breadfruit–Soybean–Corn Snack. *INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH.* 2013;2(9):212–216.

23. Human vitamin and mineral requirements. Report of a Joint FAO/WHO expert consultation Bangkok, Thailand. WHO; 2002. 303 p.

24. Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline. Washington DC: National Academies Press; 1998. 592 p.

25. Bast A, Van der Plas RM, Van den Berg H, et al. β–Carotene as antioxidant. *European Journal Clinical Nutrition.* 1996;50(S3):S54–S56.

26. Santos MS, Meydani SN, Leka L, et al. Natural killer cell activity in elderly men is enhanced by beta–carotene supplementation. *Am J Clin Nutr.* 1996;64(5):772–777.

27. Bell S, Becker W, Vásquez–Caicedo AL, et al. Report on Nutrient Losses and Gains Factors used in European Food Composition databases. *Federal Research Centre for Nutrition and Food, Karlsruhe, Germany*. 2006:1–20.

28. Zabidi MA, Karim NA, Sazali NS. Effect on Nutritional and Antioxidant Properties of Yellow Noodles Substituted with Different Levels of Mangosteen (*Garcinia mangostana*) Pericarp Powder. *International Journal of Biological, Biomolecular, Agricultural, Food and Biotechnological Engineering.* 2015;9(5):487–491.

29. Ullah RJA, Khader JA, Hussain I, et al. Investigation of Macro and Micronutrients in Selected Medicinal Plants. *African Journal of Pharmacy and Pharmacology.* 2012;6(25):1829–1832.

30. Wani TA, Sood M, Kaul RK. Nutritional and Sensory Properties of Roasted Wheat Noodles Supplemented with Cauliflower Leaf Powder. *Annals. Food Science and Technology.* 2011;12(2):102–107.

31. Institute of Medicine (US) Standing Committee on the Scientific Evaluation of Dietary Reference Intakes. Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride. Washington DC: National Academies Press; 1997. 448 p.

32. Yadav DN, Sharma M, Chikara N, et al. Quality Characteristics of Vegetable–Blended Wheat–Pearl Millet Composite Pasta. *Agricultural Research.* 2014;3(3):263–270.

33. Baljeet SY, Ritika BY, Manisha Kumari, et al. Studies on suitability of wheat flour blends with sweet potato, colocasia and water chestnut flours for noodle making. *LWT–Food Science and Technology.* 2014;57(1):352–358.

34. Okafor GI, Ugwu FC. Production and evaluation of cold extruded and baked ready–to–eat snacks from blends of breadfruit (*Treculia africana*), cashewnut (*Anacardium occidentale*) and coconut (*Cocos nucifera*). *Food Science and Quality Management.* 2014;23:65–77.

35. Pai, DA, Blake OA, et al. Importance of extensional rheological properties on fibre–enriched corn extrudates. *Journal of Cereal Science.* 2009;50(2):227–234.

36. Turksoy S, Ozkaya B. Pumpkin and carrot pomace powders as a source of dietary fibre and their effects on the mixing properties of wheat flour dough and cookie quality. *Food Sci. Technol. Res.* 2011;17(6):545–553.

37. Yahyaa M, Tholl D, Cormier G, et al. Identification and Characterization of Terpene Synthases Potentially Involved in the Formation of Volatile Terpenes in Carrot (*Daucus carota L.*) Roots. *J Agric Food Chem.* 2015;63(19):4870–4878.

38. Foschia M, Peressini D, Sensidoni A, et al. The effects of dietary fibre addition on the quality of common cereal products. *Journal of Cereal Science.* 2013;58(2):216–227.

39. Piwińska M, Wyrwisz J, Kurek M, et al. Hydration and physical properties of vacuum–dried durum wheat semolina pasta with high–fibre oat powder. *LWT– Food Science and Technology.* 2015;63(1):647–653.

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